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NASA TECHNICAL MEMORANDUM

NASA TM-88494

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GEOLOGICAL-MORPHOLOGICAL DESCRIPTION OF THE SEDNA AND GUINEVRE
PLANITIAE ON VENUS (PHOTOMAP SHEETS B-11, B-20, B-21)

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Translation of: "Geologo-morfologicheskoye opisaniye ravnin
sedny i ginevry na venerye (listy fotokarty B-11, B-20, B-21),"
Astronomicheskiy vestnik, Vol. 20, No. 3, 1986, "Nauka" Press,
Moscow, pp. 163-76 (UDC 523.42)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 SEPTEMBER 1986

(NASA-TM-88494) GEOLOGICAL-MORPHOLOGICAL
DESCRIPTION OF THE SEDNA AND GUINEVRE
PLANITIAE ON VENUS (PHOTOMAP SHEETS B-11,
B-20, B-21) (National Aeronautics and Space
Administration) 15 p

N87-15139

Unclas
43650

CSCL 84B G3/91

STANDARD TITLE PAGE

1. Report No. NASA TM 88494	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle GEOLOGICAL-MORPHOLOGICAL DESCRIPTION OF THE SEDNA AND GUINEVRE PLANITIAE ON VENUS (PHOTOMAP SHEETS B-11, B-20, B-21)		5. Report Date SEPTEMBER 1986	6. Performing Organization Code
7. Author(s) A.A. Pronin, G.A. Burba, N.N. Bobina, Yu.S. Tyufin, A.I. Sidorenko, S.A. Kadnichanskiy, M.V. Ostrovskiy, V.A. Kotelnikov, O.N. Rzhiga, G.M. Petrov, Yu.N. Aleksandrov, V.A. Shubin and N.V. Rodionova		8. Performing Organization Report No.	10. Work Unit No.
9. Performing Organization Name and Address SCITRAN Box 5456 Santa Barbara, CA 93108		11. Contract or Grant No. NASW- 4004	13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code	
15. Supplementary Notes Translation of: "Geologo-morfologicheskoye opisaniye ravnin sedny i ginevry na venerye (listy fotokarty B-11, B-20, B-21)," Astronomicheskiiy vestnik, Vol. 20, No. 3, 1986, "Nauka" Press, Moscow, pp. 163-76 (UDC 523.42)			
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17. Key Words (Selected by Author(s))		18. Distribution Statement Unclassified and Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 15	22. Price

GEOLOGICAL-MORPHOLOGICAL DESCRIPTION OF THE SEDNA AND GUINEVRE PLANITIAE ON
VENUS (PHOTOMAP SHEETS B-11, B-20, B-21)

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Presented are descriptions and maps of the region of Sedna and /163*
Guinevra Planitiae--representatives of the largest geological provinces on Venus comprised of volcanic rock. Units of different age are isolated and their relations are given, as well as interpretations of proposed mechanisms of formation.

Three sheets of the photomap of Venus fall within the boundaries of the described territory. Their boundaries have the following coordinates: Sheet B-11 -- $\lambda = 315-0^\circ$ e. long, $\varphi = 60-40^\circ$ n. lat.; sheet B-20-- $\lambda = 300-330^\circ$ e. long, φ from 40° n. lat. to the margin of the photo on the south; sheet B-21-- $\lambda = 330-0^\circ$ e. long φ from 40° n. lat to the margin of the photo on the south.

The selection of boundaries of the described section was determined by the fact that only map frame B-11 provides a full photo, while sheets B-20 and B-21 only along their northern edges, approximately to 30° n. lat, so that they are slight augmentations to the full sheet B-11.

The scheme of obtaining the images, compilation and location of the photomaps was described by us earlier [4]. Therefore, here we will give a description only of the structures on the surface and their geological interpretation.

The basic geological-morphological formations of the studied territory are represented by the southern part of the Lakshmi structure in the north of sheet B-11, the Sedna plain (sheets B-11, B-21) and the Guinevre plain (sheet B-20). The descriptions are also compiled in accordance with this list (Fig. 1-3).

SOUTHERN MARGIN OF LAKSHMI PLATEAU

Along the northern boundary of the territory is the southern part of the Lakshmi structure. Here the plateau appears on sheet B-11 in the form of a small section which is framed from the south by a narrow band of mountain structures (Danu mountains) approximately 100 km in width. These consist of linear ridges and vallies between them, oriented almost everywhere along the edge of the plateau. The edge itself here has the form of an obtuse angle (120°), turned with its apex to the south. Individual ridges within the band /167 may be seen for tens of kilometers in length (100 km) and have a width of

* Numbers in margins indicate foreign pagination.

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10-15 km. Judging by the general morphology, the ridges are formed by compression folds or outcroppings of tectonic "scales" of the overlapping type. Near the southern extremity of the plateau, where the edge of the plateau changes its directing from west-northwest to northeastern, two systems of ridges running parallel to the framing coexist and intersect at an angle of around 60° (Fig. 1-3).

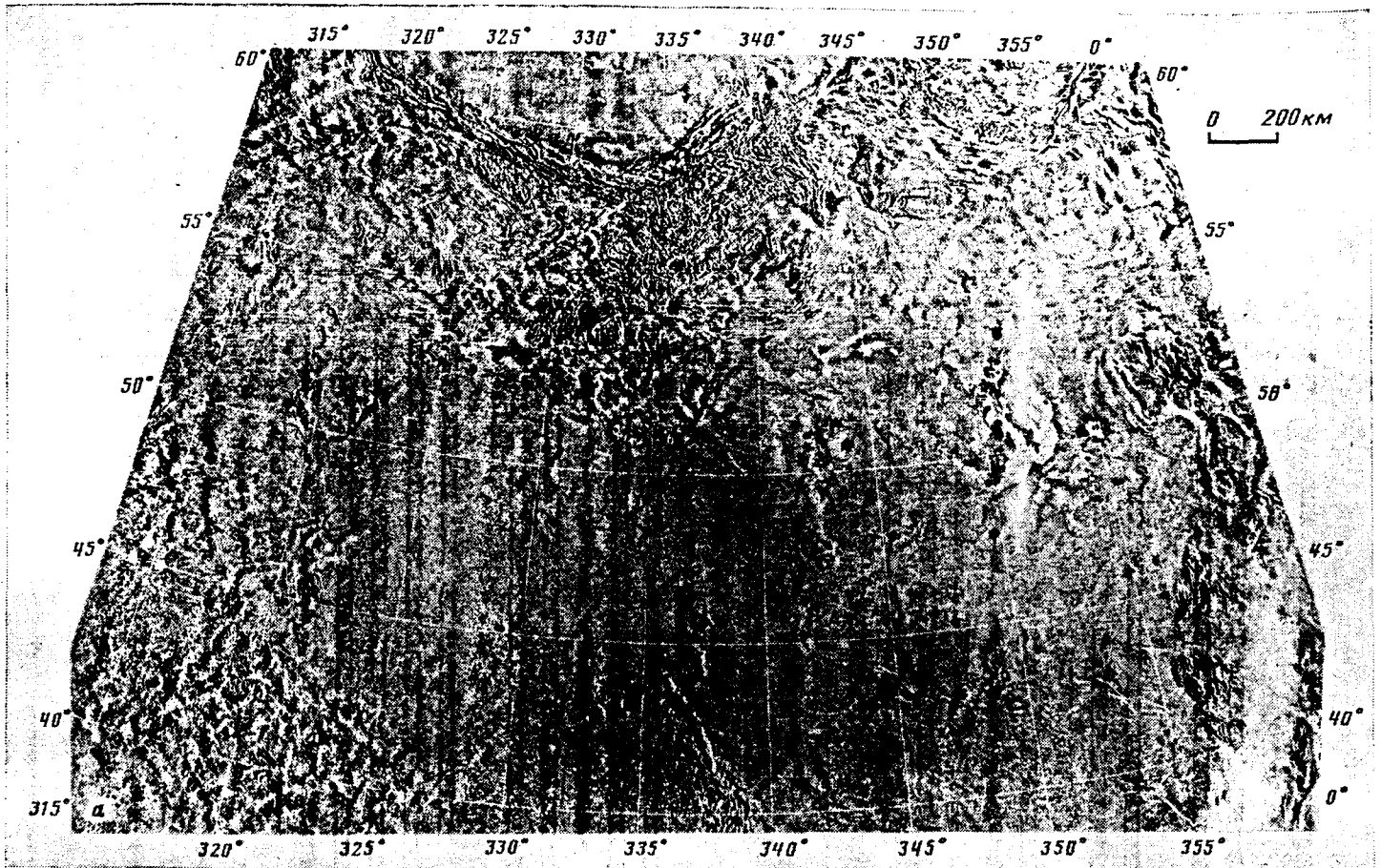


Fig. 1a.

Corresponding to the band of linear ridges are the elevations along the /167 boundary of the plateau (Danu mountains) and the shelf turned to the south which is 3-5 km in height (Vesta shelf). On the south the foot of the shelf borders an area of chaotic relief--Kloto Tessera, which extends in a band 400 km wide and 1000 km long in a northeasterly direction. The segmented relief in this area consists of chaotically oriented low ridges and elevations with a characteristic size of tens of kilometers. The terrain of this type is similar to the formations called parquet. The structure of the southeastern

boundary of Kloto Tessera is notable. It has a "torn" appearance and characteristic arch-like depressions evident in several places. Together with the arch-like fault on the northeast of the tessera, which breaks up the structure of the parquet and emphasized by two depressions with relatively smooth bottoms, the situation prompts the idea of the development here of large-scale landslides, along which the blocks of parquet slipped down with formation of break-off niches in the direction of Sedna plain and in accordance with the regional incline of the area (Fig. 4). Here, the arch-like fault on the northwest of the tessera should be considered as preparing landslides which did not occur. In a southern direction the sections of sharply rugged relief almost everywhere turn into the Sedna plain gradually through a zone of gentle hilly relief, often with furrows oriented in accordance with the framing of the Lakshmi Plateau.

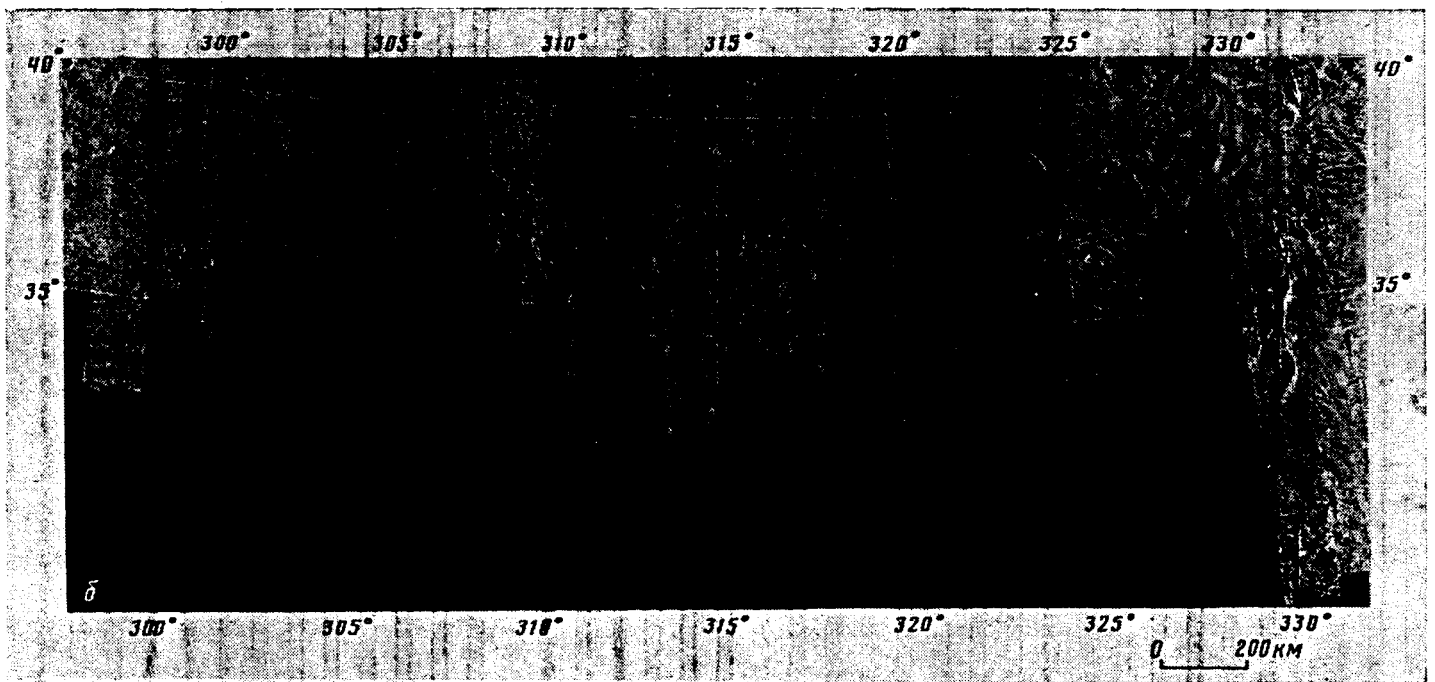


Fig. 1b

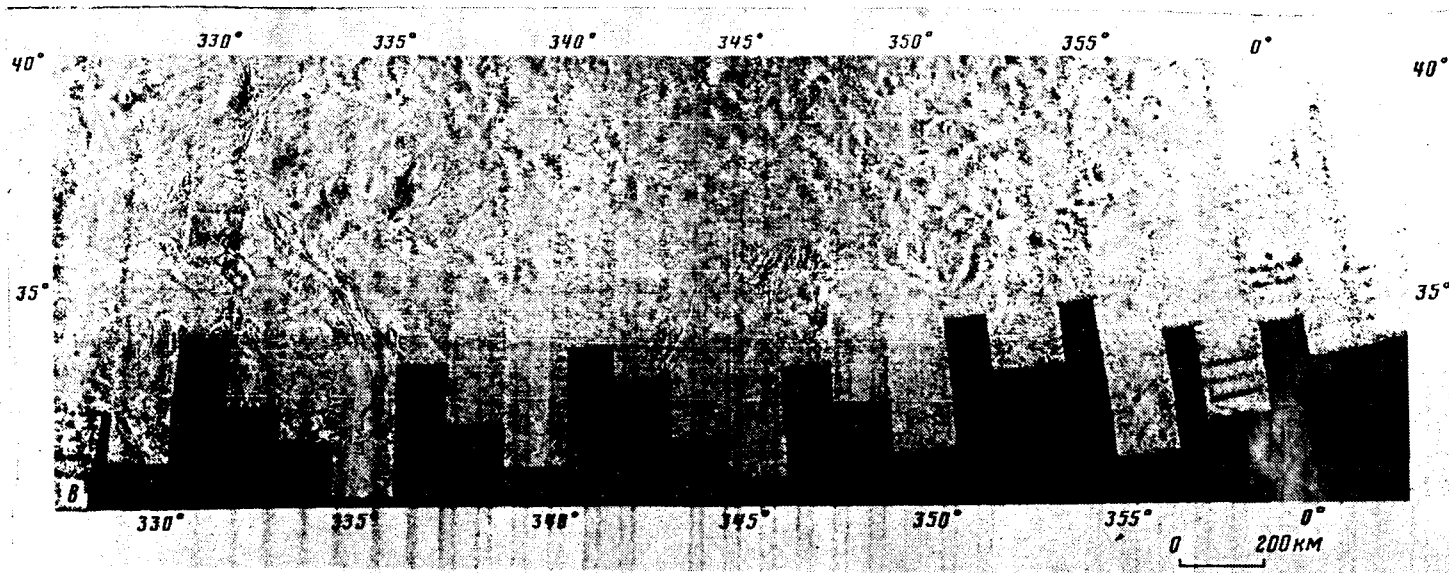


Fig. 1. Photomosaic of Venus: a - sheet B-11; b - sheet B-20, c - sheet B-21

SEDNA PLAIN

Over 3/4 of the described area is occupied by Sedna plain with elevation marks close to zero level (a sphere with radius of 6,051 km delineated from the center of the planet's masses) or slightly lower. On the north the plain borders the mountainous region of the external framing of Lakshmi Plateau, and on the west, east and south it goes beyond the boundaries of the territory. Only in individual areas do the remnants of older relief stand out over the monotonous flat surface of the plain.

Along the eastern boundary of the territory there is a chain of parquet remnants (Manzan-Gurme tessera)--systems or chaotically oriented short ridges (first tens of kilometers in length). These remnants have 200-400 km in width, and judging by their winding boundaries with "bays" of plains material, are older than the plain. Certain remnants are surrounded by gently sloping swells 30-50 km in width, which follow the outlines of their boundaries. /169

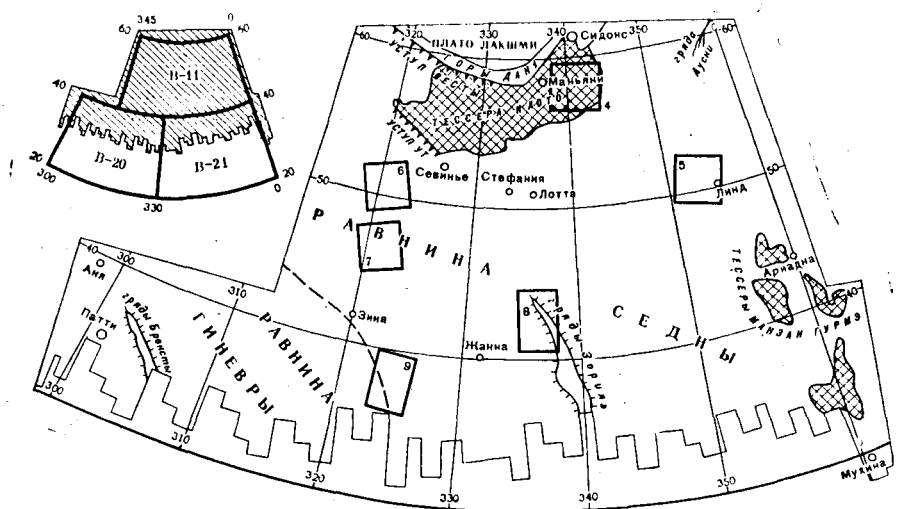
In the northeast corner of sheet B-11 the surface of the plain is not as monotonous as in the west. Here individual areas appear, judging by photo tone, which are bounded by scalloped contours, small (first tens of kilometers) cupola-shaped structures and isometric formations in the plan, in the center of which are round spots 30-40 km across with a very dark photo tone, surrounded concentrically by a diffuse light area whose external margins have a somewhat scalloped outline, and sometimes are read as ledges turned away from the center /170 of the structure. In the center of the dark spot there is sometimes a small depression. The diffuse character of the outlines and the presence in a number

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Fig. 2. Geological-morphological map of Venus (sheets B-11, B-20, B-21): 1 - complex of hilly plains; 2 - complex of flat plains; 3 - complex of Lakshmi plateau proper; 4 - complex of framing of Lakshmi plateau; 5 - complex of tessera--areas of chaotic relief (parquet); 6 - volcanic formations; 7 - individual lava flows with visible boundaries; 8 - spheres of low albedo in radio range; 9 - cupola; 10 - cupola with craters; 11 - steep sloped cupola; 12 - depressions; 13 - radial-concentric structures, assumed to be of volcanic origin ("spiders"); (continued next page)

Key to Fig. 2 (continued): 14 - shock craters; 15 - swells; 16 - furrows; 17 - ledges; 18 - lines of displacement structures opening cracks (faults); 19 - basic expanse of structures; 20 - lines of uncertain genesis; 21 - geological boundaries.



/170

Fig. 3. Scheme of geographic names and location of map sheets. Shaded territory is shown in Fig. 2.

of cases of a central depression distinguishes such structures from the shock (impact) craters and allows us to view them as volcanic formations with very gently sloping inclines such as (shield) volcanoes with a circular caldera in the center, whose bottom is either filled with loose material or represents a flat surface of lava fill, which explains its dark photo tone. The gently sloped inclines are comprised of lava flow material, whose end portions merge into the scalloped border of the framing.

Also encountered are individual cupolas with an "illuminated" and a "shaded" side, surrounded by dark areas with scalloped borders. These may also be interpreted as individual volcanic apparatus emerging under the cracks and surrounded by lava flows.

Here, in the northeastern part of the Sedna plain, there is an extensive section of surface having a light photo tone with irregular boundaries and isolated dark spots. The photo tone of the surface testifies to its increased roughness, while the absence of expressed elevations in the hypsometry testifies to its belonging to the plain. The scalloped nature of the boundaries of the light area makes us believe that it originated due to effusion, particularly since the dark spots and lines on its surface form a pattern similar to the system of expansion cracks which serve as the source of effusion (Fig. 5).

The increased roughness of the surface may be explained by the relative young age and/or difference in the composition of the lavas.



Fig. 4

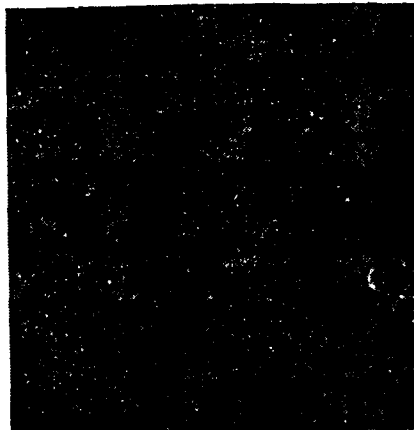


Fig. 5

Fig. 4. Section of Kloto Tessera with arch-like faults (indicated by arrows), along which settling of the blocks occurred with chaotic relief of the surface and with formation of structures reminiscent of break-off niches of gigantic landslides. Size of the area is 300 x 300 km.

Fig. 5. Presumably the surface of an areal effusion associated with cracks or a zone of cracks at the intersection of faults of northeasterly and northwesterly expanse. The faults are read on Sedna plain along the straight boundaries of dark and light fields and extend for hundreds of kilometers. Size of area is 300 x 300 km.

These and other examples convince us that the surface of Sedna plain was the arena for extensive manifestations of intensive volcanism, which was expressed in the formation of apparatus of the central type as well as in crack effusions over extensive areas. Moreover, to the south and to the west of the described sections in many areas of the plain we read "shadows" of structures of marginal resolution. These are reminiscent of volcanic structures by the presence of weakly expressed central depressions and scalloped "aprons" surrounding the gradually sloping cupolas.

Other spheres of Sedna plain appear more uniform. Nevertheless, within their marging we also find structures with indications of volcanic origin. Thus, the string of cupolas of northeastern orientation, which stretches along the broken swell expressed in the relief running in the same direction to the northeast of the plain, most probably owes its origins to the fault in the same expanse (Fig. 6).

/171

The formation with radial-concentric structure in the west of Sedna plain and expressed in the relief should also be related to the volcanic structures. The system of faults of northeastern extent along which displacements in a horizontal direction are traced, dissect this structure into blocks, which seem to be moved to either side with formation of a central depression and a young volcanic cupola in the center (Fig. 7). This situation may be interpreted as /172 the result of the disintegration and horizontal "creep" of a large volcanic structure under the effect of its own weight.

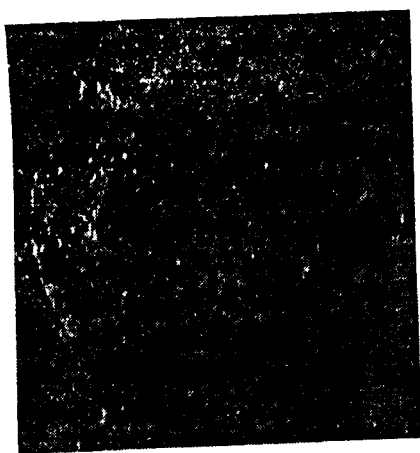


Fig. 6.

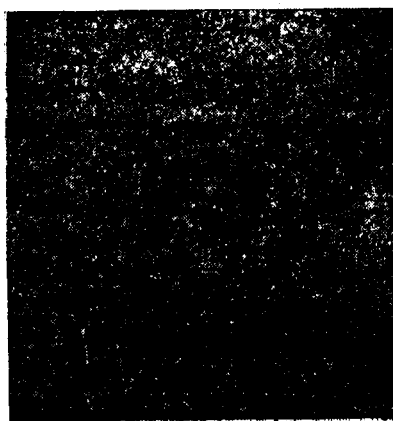


Fig. 7

Fig. 6. Five cupolas with cross-section of 20-25 km located along an almost straight, slightly curved line ~ 300 km in length, of northeastern expanse, with an almost uniform (~ 50 km) interval between them. They are rounded in the plan, with clear footings. The two northern ones have dark spots at the apex, possibly craters. Southeast of this line, about parallel to it, there extends the flat-topped steep-sloped swell which is broken in one place. Size of the area is 300×300 km.

Fig. 7. Complex plotted structure around 200 km across: central depression framed by cupolas or swells. On the east, conforming to the depression is the arch of a narrow swell. On the outside its lighter surface forms a ring around the entire structure. The external boundary of this ring is scalloped, from the south is a network of lines (light), roughly radial in relation to the structure. The size of the area is 300×300 km.

Particular attention must be given to the structure of the Zorile ridges. This is a northwestern belt of linear structures 200×800 km represented in

the south by a system of linked short (several tens of kilometers) rifts and swells, which look like "wrinkles" in the thin surface layer. In the north the structure ends in an extensive narrow swell (50 x 300 km) of the same direction. For a considerable extent under the slopes of the swell and at its northern end it is framed by linear structures of the band (Fig. 8). This leads us to believe that on the whole the material making up the swell possibly was extruded along the rift, as was the case with the Breksta ridges (see below), according to the saline diapiric type.

Located at the eastern edge of sheet B-11 are two rounded polygonal structures 270 x 300 and 160 x 260 km in size. Their contours are formed by wide gently sloping swells which look like the band of Zorile ridges, while their inside sections are filled with merging cupolas and small hilly sections. Altogether they are dissected by frequent open cracks. These forms remind us /173 of large ring-like structures ("ovoids") to the west of Ishtar Terra.

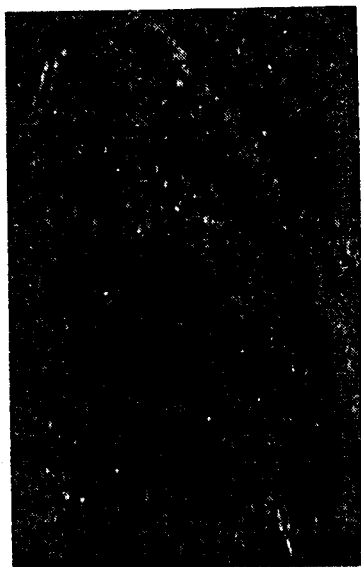


Fig. 8



Fig. 9

Fig. 8. Northern end of the Zorile ridges: gently sloping swell of northwestern extent around 300 km long and 50 km wide, framed with linear structures. Size of section 250 x 400 km.

Fig. 9. Rounded steep-sloped cupola with ridge at the peak in the center of the section. Adjoining its foot from the west is a forked flow. The light photo tone, possibly, is associated with the rough, fresh surface of the flow. Size of section 250 x 400 km.

The absence of visible significant structures in the uniform central part of the plain is possibly explained by the more extensive crack effusions with large expanse, which buried their own sources, similar to that which took place in the lunar seas. The similarity with the lunar seas is stressed by the circular outlines of the area from 41 to 53° n. lat and 322-335° e. long, partially framed by gentle swells. Possibly, this is an almost totally flooded basin with diameter of ~1100 km.

GUINEVRE PLAIN

Guinevre plain occupies a large part of sheet B-20 and is represented in the central portion by a smooth surface (complex flat plain) with individual small cupolas, evidently of volcanic origin. In the east on the boundary with Sedna plain the relief becomes more complicated and the flat plain is replaced by a hilly surface within the hilly plain complex. This is accompanied by a change in elevations from -0.5 to 0.5 km (above the flat surface). Upon close /174 examination, the hilly plain turns out to consist of gently sloping cupolas almost merged by their foothills. These are several tens of kilometers across. Sometimes there are central depressions or even rifts present on their tops. Sometimes the cupolas are represented by small and more steeply inclined forms (up to 10-20 km across, often up to the first kilometers), and sometimes by rounded formations of disk-shaped form with depressions in the center. At times the group of cupolas has a framing in the form of a gently sloping swell. Thus, within the limits of a small area in the vicinity of the point with coordinates = 325° e. long., = 38° n. long there are concentrated several cupolas and radar-light formations with scalloped edges reminiscent of lava flows (Fig. 9). In the center of this section is an extensive (around 100 km) forked flow adjoining the round steep sloped cupola with a ridge, around 25 km in diameter. It appears that the flow had its beginnings under the cupola and flowed to the west.

From the southwest to the hilly plain there adjoins a section where the linear structures of northeastern extent are developed. These are joined ridges and furrows formed at the boundary of the section, which looks like the remnant of ancient relief showing under the deposits of the flat plains (Fig. 1).

In the west of Guinevre plain are developed linear structures which have come to be called the Breksta ridges. These are two bands of linear structures

of northwestern extent 300 and 500 km in length and a band of northeastern extent adjoining them from the north, similar to the cross-piece in the letter Π . The linear structures are most clearly expressed in the longest band of northwestern extent and represent a subparallel system of joined ridges and furrows externally similar to the system of expansion cracks at the arch of the linear uplift. In some places these structures are displaced by transverse lines of disruptions. In the central part the band is complicated by a cupola which is extended in the same direction. In the plan it has a lenticular form and is framed on the edges by rifts. The impression is formed that the cupola is comprised of a material which was introduced into the zone of expansion (Fig. 1).

In the section of plain between the ridges we read assuredly two positive structures in the form of disks with central depressions. One, of smaller dimensions, is north of Patti crater, and has the dimensions of 100 x 60 km. The other, even farther to the north is 150 x 100 km. In the southwestern corner of the described territory there is an isometric section of surface divided by a system of meridional ridges and furrows, similar to the remnants of ancient relief.

On the surface of Guinevre plain there are barely discernible extensive lines, which look like the boundaries of a surface of different photo tone. The lines form an orthogonal system of northeastern and northwestern extent, and their length reaches several hundred kilometers.

INTERPRETATION OF GEOLOGICAL STRUCTURE

The geological-morphological analysis which allows us to isolate types /175 of terrain on the surface, with further interpretations rests on the assumption that geological complexes correspond to types of terrain. Therefore, a geological-morphological map is synthetic (built on more than one principle). Along with individual morphologically expressed formations, it also makes an effort to show the distribution of isolated geological complexes and to interpret their genesis.

The most widespread within the margins of the studied territory is the complex of flat plains. It is represented most probably by flows of volcanic lava, evidently of basalt composition [1,6]. We see them in the northeastern part of sheet G-11, where they are evidently the youngest in age. On the

rest of Sedna plain the differences in radio brightness of the individual lava flows possible disappeared under the influence of superficial processes. The average age of the plains in the zones of the photographs taken by "Venera-15" and "Venera-16" judging by the density of distribution of the impact craters imposed on them is evaluated to be a value on the order of 1 billion years [4]. Evidently, the age of the surface of Sedna plain is about the same. The age of the young lava flows in the northeastern quarter of sheet B-11 approximately may be evaluated by a value on the order of 200 million years or less [3].

By the presence of individual volcanic cupolas and their accumulations, Sedna plain reminds us of certain volcanic areas on Mars and on Earth, and differs from most basalt seas on the Moon. Evidently, the formation of cupolas is associated with the presence of volatile components in the lava.

Evidently, Kloto tessera should be considered the oldest geological complex. In the southeast the structures of this complex disintegrate, turning into a hilly plain, and in the northwest they are covered over with the complex of the Lakshmi Plateau framing, in which, in turn, the northern part (Danu mountains) are relatively younger.

The complex of rock of the Lakshmi Plateau proper, which comprises the continuous covering on its surface, by its relative age correlates with the complex of flat plains and is isolated independently due to its peculiar structural and hypsometric position [4].

In forming the Kloto Tessera, a significant role belongs to the structures of the gigantic landslide type, with folding of the substance comprising them and with break-off niches and lava effusions in the rear sections. The "roof tile" structure of the tessera in this model may arise according to the mechanism described in work [5].

In the complex of hilly plains, different structures are evidently united. These are numerous lava cupolas and, evidently, extrusions, remnants of large volcanic structures, "crushed" by their own weight, sections of "parquet" /176 covered over with lava, dike fields and expansion cracks, as well as relics of large circular structures "shining through" among the lava fields. We should particularly note the swell-shaped structures at the arches of linear uplifts of the Breksta and Zorile ridges, which may be formed by extrusion of the more plastic and lighter heated material from the nether regions out from under the

heavy and cold slabs of basalt coverings according to the saline cupola type.

Weakly expressed, but nevertheless extensive lines on the plains, forming a system of two primarily northwesterly and northeasterly expansions, may be the latest manifestations of the ancient planetary network of crack formation in the youngest geological complexes of the plains.

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